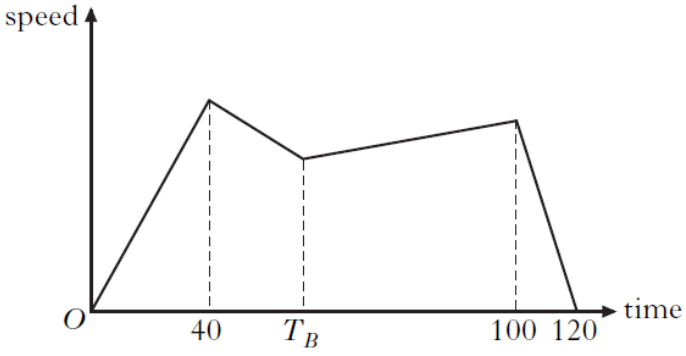
Equations of Motion

2005	**A2.** A ball is projected vertically from ground level. The ball attains a maximum height of 49 metres before returning to the ground. Assuming only the action of gravity, calculate the time of flight of the ball.	**5**
2007	**A4.** An athlete runs a 200 metre race, along a straight horizontal track, in 30 seconds. She accelerates uniformly from rest for 4 seconds, reaching a maximum speed of V m s^{-1}. She runs at this speed for 24 seconds before decelerating uniformly for the final 2 seconds, finishing the race with speed $(V-6)$ m s^{-1}. Sketch the speed-time graph for the race and calculate the value of V.	**4**
2008	**A2.** Towards the end of a long-distance race, Tessa is running at a uniform speed of 2 m s^{-1}. When she is 120 m from the finishing line she starts to increase her speed. In doing so, she accelerates uniformly at 0·25 m s^{-2} for T seconds until she crosses the finishing line. Show that T satisfies the equation $$T^2 + 16T - 960 = 0$$ and hence find her speed as she crosses the finishing line.	**6**
2010	**A1.** As a set of traffic lights changes to green, a car accelerates uniformly from rest along a straight horizontal road at a m s^{-2}. At the same instant, a lorry travelling at constant speed Um s^{-1} overtakes the car. Find an expression, in terms of U and a, for the distance travelled by the car when it draws level with the lorry.	**4**
2012	**A3.** A sprinter competes in a 100 metre race along a straight track. He starts from rest and for the first 4 seconds he has speed $\left(\frac{13}{2}t - t^2\right)$ m s^{-1}. For the the next 6 seconds he maintains a constant speed of 10 m s^{-1} before decelerating at 0·4 m s^{-2} for the remainder of the race. Calculate the total time taken by the sprinter to complete the race.	**6**
2015	**A2.** An automated train is programmed to move from rest under constant acceleration to a maximum speed of 20 m s^{-1} in a distance of 300 m. It is brought to rest under uniform deceleration in 15 seconds. Two stations are 5 kilometres apart and the train is programmed to stop at each station. Find the time taken to travel between the two stations.	**5**
2016 SP	**5.** A particle is projected vertically upwards at a speed of 14·8 m s^{-1} from a point O. Two seconds later a second particle is projected vertically upwards from O at a speed of 5·2 m s^{-1}. (a) Calculate the value of t when the two particles collide assuming that the only force acting is that due to gravity.	**4**
	(b) Determine the distance the particles are above O when they collide.	**1**
2016	**7.** An object of mass 9 kg starts from rest at an origin and moves in a straight line so that its acceleration in m s^{-2} is given as $a = 4 - \sqrt{t}$, where t is the time in seconds. Calculate its maximum speed and hence the increase in kinetic energy.	**4**

Time Graphs

2011

A2. The speed-time graph of the motion of a car as it travels along a straight road is shown below. The car accelerates from O and passes markers on the road at A, B, C before stopping at D after 120 seconds. The car passes A after 40 seconds, B after T_B seconds, and C after 100 seconds.



The speed of the car between A and B is given by $v_1(t) = -\frac{1}{2}t + 45 \quad (40 \leq t \leq T_B)$ and between B and C by $v_2(t) = \frac{1}{8}t + \frac{15}{2} \quad (T_B \leq t \leq 100)$, where the speed is measured in metres per second and time t is measured in seconds from the beginning of the motion.

(a) Calculate the speed of the car at B. **3**

(b) Calculate the distance between B and D. **3**

2016 SP

4. A train travels from Glasgow to Stirling. It starts from rest and accelerates uniformly for the first 9 km of its journey. It then travels for 46·8 km at a uniform velocity, before decelerating uniformly to rest in 7·2 km. The total journey time is 33 minutes.

(a) Sketch a velocity-time graph with appropriate units to represent this journey. **2**

(b) Calculate, in km h^{-1}, the maximum speed reached by the train. **4**

(c) State **one** assumption you have made in answering this question. **1**

2016

6. A remote controlled aircraft is flown from point A to point B. It accelerates for 10 seconds at a constant rate from rest to a take-off speed of 15 m s^{-1}.

Once airborne, it accelerates for a further 20 seconds at a slower constant rate to a cruising speed of u m s^{-1}.

It maintains this speed for 60 seconds until it lands.

The aircraft then decelerates for 10 seconds to a complete stop.

(a) Sketch a speed-time graph of the journey, clearly showing all the important information. **2**

(b) (i) If the distance travelled from A to B is 1·725 km, calculate the value of u. **2**

(ii) State one assumption you have made about the path of the aircraft during your calculations. **1**